Estimation of Rice Production Function in Rajbari District, Bangladesh: an Econometric Analysis

ISSN: 2311-8636 (Print)
ISSN: 2312-2021 (Online)

DOI prefix: 10.18034

Source of Support: Nil

No Conflict of Interest: Declared

*Email for correspondence:
md.yahiabapari@yahoo.com

Md. Yahia Bapari[1*], Md. Awal Kabir Joy[2]

[1]Lecturer, Department of Economics, Pabna University of Science & Technology, Pabna - 6600, **BANGLADESH**

[2]Lecturer, Department of Social Work, Pabna University of Science & Technology, Pabna - 6600, **BANGLADESH**

ABSTRACT

The study was undertaken to estimate the profitability and productivity of rice for local and high yielding varieties in Rajbari district of Bangladesh. To this end, random sample technique was used to collect data from 193 rice producers with the aid of well-structured questionnaire and Cobb–Douglas production form was chosen to assess the rice production functions. The ordinary least square (OLS) method was minutely applied to the data set availed from different groups of farmers namely only Local Variety (LV), only High Yielding Variety (HYV) and both variety user farmers. The Empirical result obtained from production function analysis considering only LV user farmers showed that rent of land, seed, labour, fertilizer and irrigation costs had positively effected on the gross return of rice cultivation while insecticide and ploughing costs work negatively. In the case of only HYV users, the rent of land, fertilizer, insecticide, ploughing and irrigation costs were positively related, and seed and labor costs were inversely related with rice production. Results in the case of both variety user farmers showed that labor, fertilizer, and irrigation costs of LV and rent of land, ploughing and irrigation costs of HYV acted positively while rent of land, seed, insecticide and ploughing costs of LV and seed, labor, fertilizer and insecticide costs of HYV worked inversely in producing rice. Results also showed that most of the farmers produced rice in the rational stage (stage – II) of the production function over the study area. All results emphasized that irrigation cost is the key variable which plays a significant role in producing more rice in the study area. Finally, some suggestions are made towards increasing the volume of rice production in Rajbari district.

Key Words: Rice, Production Function, Local Variety, High Yielding Variety, Rajbari, Econometric Analysis

INTRODUCTION

Bangladesh is a well-watered, richly fructiferous and riverine country. It is often called evergreen country. It is mainly an agrarian country because agriculture is the mainstay of its economy. The country is one of world's largest producers of Jute, Rice, Fisheries,

Tropical Fruit, Mango, Potato, Tea, Pineapple, Onion, Banana, and some other important grains. Agriculture is the single largest sector of the economy which accounts for as much as 19.41% (estimated) share of the Gross Domestic Product (GDP) and employs 43.53% of the labor force (BER, 2013). This sector plays a vital role in the growth and stability of her economy as it indicated by its contribution to GDP, supply raw materials for industry, employment generation, and export earnings. The sector is, therefore, known as the growth engine for the non-agriculture sector with having a multiplier effect.

The agriculture sector consists of four sub – sectors namely crop, forest, livestock, and fisheries where crop sector's contribution to GDP is 10.86%. Forestry, livestock and fisheries sectors' contribute to GDP are 1.66%, 2.51% and 4.39% respectively (BER, 2013). Among the vast agriculture sector in Bangladesh rice includes in the crop sub- sector and it is an important food crop for the country. Rice is the most important cereal food crop given its contribution to GDP, employment creation, food security and supply of other things related to food in addition to its linkages with many other sectors of the economy of Bangladesh. It is consumed as prime food by around half of the entire population of the world next to wheat (Eleanor, 1975; Chandler, 1979).

By Biyi (2005), rice is consumed by more than 4.8 billion people in 176 countries and is the most important food crop for over 2.89 billion people in Asia, over 40 million people in Africa and over 150.3 million people in America. It is the prime and foremost cereal of Bangladesh and is consumed by the Bangladeshis as the principal food.

Three types of rice are mainly produced such as Aus, Aman, and Boro in the three distinct seasons namely Boro (January to June), Aus (April to August), and Aman (August to December) in Bangladesh. For instance, local varieties of 1. Aus: Dular, Dharial, Shaita, Panbira, Shisumoti, Bina-7, BR- 11, 2. Aman: Latishali, Nizershail, Jhingashali, Pajam, Rajashail and 3. Boro: Tepi boro, Khoya boroand high yielding varieties of 1. Aus: Nizaini (BR20), Niamot (BR21), Rahmat (BR 24), and Shraboni (BR 26) 2. Aman: Brrishail, Binasbail, Dulabhog (BR 5), Kiron (BR 22), and Dishari (BR, 23) and 3. Boro: BR 17 (Hashi), BR 18 (Shahjalal), and BR 19 (Mongol), BRRI dhan 28, and BRRI dhan 29.Area under rice cultivation as a percentage of total cultivated area was about 77.02 percent in 2010- 2011; of which Aus is 10%, Aman 49% and Boro 41% (BBS, 2011). Another type of rice is IRRI, which has recently been seen in Bangladesh.

Rice is a basic food and strategic commodity in Bangladesh. It covers almost 10.90 million hectare of land in Bangladesh and producing nearly 94 % of total food requirements (YASB, 2011). About 81% of total agricultural production comes in the form of rice (BBS, 2005). Rice supplies about 71% of the total calories and 51% of the protein in a Bangladeshi diet (BBS, 1998). Rice accounts for about 40% of all employment; Rural and Urban poor people spend around 60 % of their income on rice (BBS, 2011). Rice-bran based oil industry can emerge as potential industry rice.

Rice is produced by using labour- intensive technique in our country. It supplies Chira, Muri, Khai, Cakes, and many other potable foods. Straw, Stalks, and Chaffs obtained from rice are used as vital fodder for cattle. Rice paper obtained from rice is used as a thin paper in China. Many agro-based industries such as rice mill, Bakery and many hotel and restaurant are established by rice. Rice can expand the market for Industrial goods.

The soil and climate status of Bangladesh are very suitable for producing rice. All of the districts of Bangladesh viz. Barisal, Sylhet, Dinajpur, Rajshahi, Mymensingh, Comilla, Khulna, Faridpur, Rajbari, Manikgonj, Sirajgonj, and others are important regions for

producing rice. Rajbari district is one of the highly producing rice regions in which almost all villages are cultivated rice with great cordial. The district is primarily agro-based where rice is the second single dominated crop (first is jute) produced simultaneously with other minor crops and farming is the principal occupation of the majority of its population and their livelihood almost completely depends on agricultural activities. They have also little scope for complementary occupation during the cropping seasons. All these features confirm to the typical characteristics of Bangladesh agriculture.

Many studies have been done in this field by various researchers, institutions, and experts within the country as well as outside the country (Bhujel, and Ghimire, 2006; Olujeyo, 2008; Rashidan, 2002 and Majumder *et al*., 2009).

Bhujel and Ghimire (2006) estimated the rice production function using farm size, use of Nitrogen, Phosphorus, Potash, HYV seed and human labour. The hypothesis tested was found true that the farmers received more net profit from winter rice in the survey area as Benefit-Cost ratio for this crop was found 1.73.

Majumder *et al*., (2009) showed that the impact of various inputs (human labor cost, seedling cost, fertilizer cost and insecticide cost) on boro rice production was significant for all tenure class although the level of significance vary. They found the elasticity of substitution for the owner, cash tenant and crop share tenant were 0.63, 0.85 and 0.62 respectively which implies that growers allocated their resources at the efficient stage of production (Stage- II) where diminishing Returns to Scale (RTS) existed.

Olujenyo (2008), found a positive relationship between total output of maize production and age, education, labor, non- labor input cost and type of season and inverse relationship between output of maize and farm size, years of experience and sex of respondents. The study found that Maize farming was profitable in the study area with gross margin and net returns of N2637.80 and N2141.00 respectively.

Hussain and Saed (2001) estimated the production function in Jordan's agriculture sector is characterized by increasing return to scale and the analysis indicated that agriculture use the intensive labor method since the elasticity of labor was estimated, to be 0.455 compared to that of capital which was estimated to be 0.130.

Moniruzzaman *et al*., (2010) examined the differences in input use, costs and returns of the borrower and non- borrower rice farmer in Mymensingh district.

So, the estimation of rice production function is available for other districts within the country as well as the other countries, but still today there is no study considering the estimation of the production function for rice of local and high yielding varieties in Rajbari district. As a result, it is still unknown as to which inputs are significant in rice production in the case of Rajbari district and also the factors which have negative effect on rice productivity in the region.

OBJECTIVES

The objectives of this study are (i) to identify the determinants of rice production in the study area; (ii) to estimate the Rice Production Functions for (a) only local variety users' farmers; (b) only HYV users' farmers; and (c) both local and high yielding varieties users' farmers in the Rajbari district, and also estimate quantitatively the extent of influence of the inputs on the production of rice in the study area; (iii) to show the differences among the determining rice production functions; (iv) to show the RTS and Elasticities of rice production in the study areas and (v) to draw implications of the results and findings.

METHODOLOGY

Selection of the Study Area

The study demands multi-stage random sampling method with Rajbari district the first stage and respondent being the last. The present study was confined to Rajbari district purposively. Then the researcher selects randomly two unions namely Dadshi, which is near to Rajbari town and Barat, which is comparatively remote area from the town. From each union, one village is selected randomly through random sampling table considering time and fund constraints. The selected villages are Kamalpur and Bhabadia from the Dadshi and Barat union respectively.

Selection of the Respondents

From those two villages regular growers of rice were taken into consider (Union parisad records). From the records, 193 sample farmers were selected randomly by using random sampling technique. In the selection of the respondents, the researcher collects 98 and 95 farmers from Kamalpur and Bhabadia villages respectively.

Questionnaire and interview Method

For the collection of data the researcher has prepared a well-structured questionnaire on the basis of the research objectives. To test the accuracy of questionnaire the researcher made pilot surveys. Then the researcher himself went to the farmers' house and took interviews. In this way a total of 193 farmers have been interviewed.

Sources of Data

Both primary and secondary data have used in this study. Primary data has been collected from the selected sample villages from February to April, 2013 using a well-prepared questionnaire. Secondary data were collected from various government and non-government organizations such as Yearbook of Agriculture Statistics of Bangladesh (YASB), Bangladesh Bureau of Statistics (BBS), Bangladesh economic review (BER), relevant journals and printed documents, Wikipedia- the free encyclopedia, etc.

Empirical Model

The model specified was as the Cobb – Douglas form of production function:

$$Y = AX_1^{\beta 1} X_2^{\beta 2} X_3^{\beta 3} X_4^{\beta 4} X_5^{\beta 5} X_6^{\beta 6} X_7^{\beta 7} e^{\mu i}$$

Where, Y =Gross Revenue per bigha (tk). A=Constant, X_1 =1% of the value of total cultivated land/ rent of land (tk), X_2 =Seed Cost per bigha (tk), X_3 =Labour Cost per bigha (man days in tk.), X_4 =Fertilizer Cost per bigha (tk), X_5 =Insecticide Cost per bigha (tk), X_6=Ploughing Cost per bigha (tk), X_7=Irrigation Cost per bigha (tk), β_1 toβ_7 =Coefficients to be estimated and μ=Error term

The log-linear form of it as:

$$\ln Y = \ln A + \beta_1 1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \mu_i$$

Let, $\ln A = \beta_0$, the equation converted into as:

$$\ln Y = \beta_0 + \beta_1 1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \mu_i$$

This production function was estimated by using OLS method with the aid of SPSS version 17 software.

Elasticity of production (Ep)

The elasticity of production refers to the percentage change in output on the percentage change in input, if other factors are held constant. It is conveyed as:

$$E_p = b_i \frac{Y}{X_i} \frac{X_i}{Y}$$ (Koutsoyeannis, 1979)

Where, bi= Regression coefficient, Y=Gross revenue obtained from rice production, Xi=Resources whose elasticity is being estimated.

Assuming a Cobb-Douglas production function, the elasticity of production is as follows:

$$E_p = b_i$$

If Ep = 1, Production elasticity is unity

Ep> 1, Production is elastic, and

Ep<1, Production is inelastic.

Return to Scale (RTS)

The RTS is obtained by adding together the regression coefficients of all explanatory variables in Cobb-Douglas production function. Mathematically,

$$\text{RTS}= \sum_{1}^{n} bi$$

Where, RTS =Return to Scale, n= number of regression, and bi= regression coefficients

Therefore, if RTS=1, implies constant return to scale

RTS>1 means increasing return to scale and

RTS<1 implies decreasing return to scale.

Profitability analysis

Gross margin: GM = TR – TVC

Net return: NR = TR – TC

Where, TR =Total revenue/bigha (tk), TVC =Total Variable Cost/ bigha (tk) and TC=Total Cost/ bigha (tk).

DATA ANALYSIS AND DISCUSSION OF RESULTS

Socio-economic characteristics of the Farmers

The socio-economic characteristics of the respondents are very important for understanding the capability and decision making power of the farmers and these also help to capture the productivity, profitability and cost- benefit scenario of the rice production in the study area. These are presented in the following:

Age Respondent

The age of the farmer is an important determinant to perform agricultural activities efficiently which is shown following table 1.

Table 1: Age distribution of the Farmers

Age group	Frequency	% of total
24-30	15	8
31-40	49	25
41-50	72	37
51-60	40	21
61-72	17	9
Total	193	100

Source: Field survey

From the data it is found that age of the respondent's ranges between 24 to 72 years. The mean age was 46.66 years while the modal age group was 41-50 years as depicted in table 1. Nearly about 92 percent farmers belong to the age group between 31 to 60 years. Only 8 percent of the respondents were between 24-30 years. Therefore, one can infer that rice farmers in the study areas are ageing.

Main Occupation

The Main occupation is determined considering the contribution of different sectors to the household income. It is found that the respondents are engaged themselves in various occupations. The occupations of them are also influenced by the location of the areas. However, the distribution of the respondents based on their main occupation is presented in below table 2.

Table 2: Occupational distribution of farmers

Occupation	**Frequency**	**% of Total**
Agriculture	176	90
Wage Labour	5	3
Rickshaw /*Van* Pulling	1	1
Service (Private and public)	6	3
Business	5	3
Total	193	100

Source: Field Survey, 2013

Marital Status

Marital status of the respondent is an important factor that affects economic activities. Females are always less involved in economic activities while males are the best fit. Considering the marital status of the respondent, shown in Table 3; it is found that 99 percent of the respondents were married while 1 percent of were in widow/widower categories separately:

Table 3: Marital Status of the Respondent

Marital status	Frequency	% of total
Married	191	99
Unmarried	0	0
Widow/Widower	2	1
Total	193	100

Source: Field Survey

Educational level

Education helps to develop the capacity of the people. An educated person has can get and analyses the information from various sources. This capacity makes a person different from the other people. Education of the farmers plays an important role in adopting new technologies and strategies of cultivation and solving many problems related to dealing with daily activities of the family.

Table 4: Educational Status of the Respondent

Educational Status	Frequency	% of Total
No formal education	117	60.6
Primary	59	30.6
SSC	14	7.3
HSC	2	1
Graduate/Post graduate	1	0.5
Total	193	100

Source: Field survey, 2013

Table 4 provides the information about the educational level of the fanners. Result also show that majority of farmers in the study area are illiterate and primary education category. This could have negative impact on the adoption of new techniques of production.

Family Size

Family is a social institution where children, adult and economically active members are live together. Family size plays an important role in the economic and social life of farmers. It has diversified effect on the socioeconomic level of the farmers. A large family must have more labor to earn through different types of activities. On the other hand large families require higher expenditures to fulfill the daily needs of the family members.

Table 5: Distribution of the Farmer by Family Size

Number of Family Member	Frequency	% of total
2-4	23	11.9
5-8	120	62.2
9-12	41	21.2
13-16	7	3.6
17 & above	2	1
Total	193	100

Source: Field Survey.

Table 5 shows that among the 100 respondents about 39% respondents reported themselves that, they have 1-4 family members while respondents who had 5-8 family members were 62.2%. Again 8 % families are within the joint family category. The maximum size of the collective family is found to be 14 members.

Farming Experience

Experience is an important tool in order to operate agriculture activities. An experienced farmer can handle easily how to till land properly, spray pesticide and optimum doses of fertilizers etc than an inexperienced farmer.

Table 6: Distribution of the Farmers according to Year of Experience

Years of experience	No. of farmers
1-10	18
11-20	51
21-30	68
31-40	44
41-50	12
Total	193

Source: Field Survey, 2013

The study areas are experienced from 2 to 50 years. In Table 6, most of the respondents have 21-30 years experience who are related with agricultural activities, which is supposed to have positive impact on output, all things being equal.

Agricultural Training status

Training is the important tool for development of skill and knowledge. It was found from the study area that, only 9.3% farmers had agricultural training while 90.7 % farmers had no training.

Farm Holding Size of the Respondents

A farm holding is a techno-economic unit of agricultural production comprising all livestock kept, and all the land which is wholly or partly for agricultural purposes and is operated under a single management by one person or with others, without regard to title, size or location. Farm holdings were broadly classified into following four categories.

Table 7: Farm holding size of the Respondents

Category	Farm size (acre)	Frequency
Marginal farmers	0.05-0.49	16
Small farmers	0.50-2.49	138
Medium farmers	2.50-7.49	28
Large farmers	7.50-above	11
Total		193

Source: Field Survey, 2013

Distribution of the Farmers by Using Seeds

Seed is an important factor that influences both productivity and profitability of farmers. In the study areas respondents use two types of seed - LV and HYV seeds (Table 8).

Table 8: Distribution of the Farmer by using Seeds

Types of Seed	Frequency	% of Total
Local Variety (LV)	43	22
High yielding variety	65	34
Both LV & HYV	85	44
Total	193	100

Source: Field Survey, 2013

Table 8 shows that 22% respondents reported themselves as the user of local varieties seed while 34% respondent are the user of high yielding varieties. The rest of the respondents equal to 44% use both local and high yielding varieties.

Distribution of the Farmers by using Fertilizers

Fertilizer is an organic substance prepared artificially in the factory and applied to the soil to supply nutrient to plants or their growth and development. Fertilizer is considered to be the medicine of plants which influence productivity. In the study area, the respondent reported themselves as the user of two broad types of fertilizers namely chemical fertilizer and Compost or cow dung fertilizer.

Distribution of the Farmers According to Irrigation Method

In the study area, the use of irrigation methods is classified into two categories viz. (i) surface and (ii) underground water.

Distribution of the farmers according to irrigation method is presented Table 9.

Table 9: Distribution of the Farmers according to Irrigation Method

Irrigation source	Frequency	% of Total
Surface water	11	6
Underground water	150	77
Both Surface and Underground water	32	17
Total	193	100

Source: Field Survey, 2013

Profitability analysis

The profitability analysis is presented in table 10. The gross margin per bigha was estimated as Tk. 706.47 for LV and Tk. 4035.26 for HYV, which shows the rice farming was generally profitable in the study area. The table shows that total revenue was larger than the total cost incurred by the represents. So, the net return per bigha was Tk. 388.86 for local varieties and Tk. 3618.11 for high yielding varieties. Finally, the profit analysis was very strong by using the benefit – costratio, estimated in bigha, which was 1:1.03 for LV and 1:1.23 for HYV. By this analysis, it must say that the cultivation of rice in both local and high yielding varieties is profitable but the profit of HYV's rice must greater than that of LV. All things being equal, greater effort in rice production will enhance the income of the respondents.

Table 10: Profitability analysis for rice production in the study area

For LV's rice

Variables (per bigha)	Mean	Minimum	Maximum	SD
A. Total revenue	12941.20	6598	22400	6499.67
B. Total cost (C+D)	12552.33	8905	16975	5919.78
C. Total variable cost	12234.73	8905	16975	5919.78
D. Total fixed cost	317.60	110	650	218.10
GM = (A - C)	706.47	67.97	1475.32	1257.23
Net return = (A - B)	388.86	187.25	950.24	318.22
BCR = A/B = 1:1.03				

For HYV's Rice

Variables (per bigha)	Mean	Minimum	Maximum	SD
A. Total revenue	19071.10	11160	29000	8626.95
B. Total cost (C+D)	15452.99	11048	19731	6473.92
C. Total variable cost	15035.84	11048	19731	6473.92
D. Total fixed cost	417.15	210	950	253.51
GM = (A - C)	4035.26	1524.38	7046.79	574.25
Net return = (A - B)	3618.11	1524.38	7046.79	574.25
BCR = A/B = 1:1.23				

Source: field survey, 2013

Estimation of Rice Production Functions

The primary information was collected of 193 farmers from the various farmers in both Kamalpur and Bhabadia villages from Dadshi and Barat unions which are situated in the Rajbari district of Bangladesh but now, to estimate the Rice production functions of both local and high yielding varieties the data have divided into three different categories such as:

(i) The respondents of farmers, who produce only local variety's rice,
(ii) Farmers who produce only high yielding variety's rice and
(iii) Those farmers who produce both local and high yielding variety's rice.

The first, second and third categories include 43, 65 and 85 farmers in the study area. The estimated Rice Production functions for each category obtained by using Cobb- Douglas production function and applying OLS method are given below-

Table 11: estimated production functions for different varieties of the respondents

The estimated production function for local variety user farmers
$\ln Y = 4.188 + 0.004 \ln X_1 + 0.026 \ln X_2 + 0.001 \ln X_3 + 0.067 \ln X_4 - 0.053 \ln X_5 - 0.02 \ln X_6 + 0.597 \ln X_7$.
The estimated production function for High yielding variety user farmers
$\ln Y = 0.965 + 0.014 \ln X_1 - 0.022 \ln X_2 - 0.031 \ln X_3 + 0.042 \ln X_4 + 0.109 \ln X_5 + 0.052 \ln X_6 + 0.891 \ln X_7$.
The estimated production function for local variety user farmers in both case
$\ln Y = 6.177 - 0.04 \ln X_1 - 0.094 \ln X_2 + 0.227 \ln X_3 + 0.149 \ln X_4 - 0.126 \ln X_5 - 0.122 \ln X_6 + 0.324 \ln X_7$.
The estimated production function for High yielding variety user farmers in the both case
$\ln Y = 6.755 + 0.004 \ln X_1 - 0.013 \ln X_2 - 0.03 \ln X_3 - 0.009 \ln X_4 - 0.05 \ln X_5 + 0.015 \ln X_6 + 0.422 \ln X_7$.

The impact of selected seven explanatory variables on gross return of rice are given below-

Table 12: Estimated values of coefficient and related statistics of Cobb- Douglas production function model

Explanatory variables (per bigha)	Local variety user farmers	HYV user farmers	Local variety user in both variety user farmers	HYV in both variety user farmers
Constant (Intercept)	β_o = 4.188 (5.847)	β_o = 0.965 (0.899)	β_o = 6.177 (3.365)	β_o = 6.755 (11.636)
Rent of land (X_1)	β_1 = 0.004 (0.300)	β_1 = 0.014 (1.07)	β_1 = -0.040*** (-1.623)	β_1 = 0.004 (0.718)
Cost of seed (X_2)	β_2 = 0.026 (0.894)	β_2= -0.022 (-0.824)	β_2 = -0.094 (-1.276)	β_2 = -0.013 (-0.870)
Labour cost (X_3)	β_3 = 0.001 (0.016)	β_3 = -0.031 (0.733)	β_3 = 0.227* (2.149)	β_3= -0.030 (-0.939)
Fertilizer cost (X_4)	β_4 = 0.067 (1.340)	β_4= 0.042 (0.535)	β_4= 0.149 (1.142)	β_4= -0.009 (-0.268)
Insecticide cost (X_5)	β_5 = -0.053*** (-1.586)	β_5 = 0.109 (1.269)	β_5 = -0.126 (-0.975)	β_5 = -0.050*** (-1.510)
Ploughing cost (X_6)	β_6 = -0.02 (-0.395)	β_6 = 0.052 (0.674)	β_6 = -0.122 (-0.853)	β_6 = 0.015 (0.403)
Irrigation cost (X_7)	β_7 = 0.597* (12.762)	β_7 = 0.891* (14.598)	β_7 = 0.324* (5.406)	β_7 = 0.422* (11.114)
Adjusted R^2	0.827	0.804	0.343	0.606
F – value	29.709*	38.541	7.263	17.523
Durbin – Watson	2.12	2.02	2.07	1.959

Note: figures in the parentheses indicate t-values and * and *** indicate significant at 1% and 10% respectively.

In the econometric exercise, separate regressions on only local, only HYV and both variety user farmers are done to determine the rice production function.

All rice production functions have a great similarity from the point of intercept of the production function. Each has positive intercept that we see from the above tables or production function equations. So we can say that all rice production functions start graphically from the gross return (output) or vertical axis.

The production functions are similar in the case of the role of the irrigation input on gross revenue because it plays a vital and positive role to produce rice in the study area.

Finally, the collected data for all production functions are free from the autocorrelation problem because the values of Durbin- Watson statistic for all type of production functions are around to 2.

There are many aspects of dissimilarities found in the estimation of production functions which are given below-

The first dissimilarity found from the table 12 and lead equations of table 11 in the case of the relationship between inputs and gross revenue of rice production. In the first rice production function, the inputs viz. rent of land, fertilizer, insecticide, Ploughing and irrigation costs per bigha are positively related, and others are inversely related with gross revenue while in the second, third, and forth production functions the inputs viz. rent of land, seed, labor, fertilizer and irrigation costs per bigha are positively related and rest of inputs are inversely related, the inputs such as labor, fertilizer and irrigation costs per

bigha are positively related and rent of land, seed, insecticide and Ploughing costs per bigha are inversely related, and the inputs i.e., rent of land, Ploughing and irrigation costs per bigha are positively related and the inputs such as seed, labor, fertilizer and insecticide costs per bigha are inversely related with the gross revenue of rice.

The second dissimilarity found that the quantitative impact of various inputs on the gross return of rice which were found different among the production functions. The coefficients of rent of land among the production functions of lead equations (1), (2), (3), and (4) were 0.014, 0.004, - 0.04 and 0.004 respectively which implies that if 1% increase of the rent of land, others are remain unchanged, the gross revenue increases by 0.014%, 0.004% and also 0.004% for (1), (2), and (4) production functions and decreases by 0.04% for (3) production function in the study area. The Elasticities of seed cost are 0.022, - 0.026, - 0.094 and – 0.013 for (1) to (4) production functions respectively which signify that the 1% increase in respective input, others are held constant, the gross return increases by 0.022% for (1) and decreases by 0.026%, 0.094% and 0.013% for (2), (3), and (4) respectively. Others important inputs of rice production are labor, fertilizer, insecticide, ploughing and irrigation costs whose coefficients are 0.001, - 0.031, 0.227, and – 0.030 for labor, 0.067, 0.042, 0.149, and – 0.009 for fertilizer, - 0.053, 0.109, - 0.126, and – 0.050 for insecticide, - 0.02, 0.052, - 0.122, and 0.015 for ploughing, and 0.597, 0.891, 0.324, and 0.422 for irrigation cost in the (1), (2), (3), and (4) production functions respectively and therefore each of these variables affect the gross revenue in accordance with their respective values keeping others constant.

Thirdly, the values of adjusted R^2 vary among the production functions for which it is inferred that 82.7%, 80.4%, 34.3% and 60.6% variations of the gross revenue from rice production have been explained by the explanatory variables of (1), (2), (3), and (4) production functions respectively.

Finally, each model has a distinct F value such as 29.71, 38.54, 7.26, and 17.52 for production functions (1), (2), (3) and (4) respectively and each of them is at 1% level of significant which implies that the model is effective and representative.

Elasticity of Production (Ep)

The coefficients of the various inputs of production functions indicate the Elasticities of the respective rice production function by which how the inputs impact on the gross return of rice can explain. In table 13, the elasticity of each input is shown, and it is clear from the table that all inputs are inelastic along the rice production functions.

Returns to Scale

RTS is shown in table 14, which is obtained by summing all production coefficients of the respective function. In the case of only LV, only HYV, LV in both and HYV in both variety user farmers, the returns to scale are0.622, 1.055, 0.318 and 0.339 which exhibit the decreasing, increasing, and decreasing returns to scale. Therefore, one must infer that the (1), (2), and (3) production functions demonstrate the efficient stage (stage-II) and (2) exhibits the inefficient stage (stage – I) of production function.

Table 13: Elasticities of both LV & HYV's rice production functions

Inputs	Elasticity				Remarks
	Local variety user farmers	HYV user farmers	LV user in both variety user farmers	HYV in both variety user farmers	
Rent of land	0.004	0.014	0.040	0.004	Inelastic
Cost of seed	0.026	0.022	0.094	0.013	Inelastic
Labour cost	0.001	0.031	0.227	0.030	Inelastic
Fertilizer cost	0.067	0.042	0.149	0.009	Inelastic
Insecticide cost	0.053	0.109	0.126	0.050	Inelastic
Ploughing cost	0.02	0.052	0.122	0.015	Inelastic
Irrigation cost	0.597	0.891	0.324	0.422	Inelastic

Table 14: RTS for all production functions:

Categories	Returns to scale (RTS)	Remark
Local variety user farmers	0.622	Decreasing returns to scale
HYV user farmers	1.055	Increasing returns to scale
Local variety user in both variety user farmers	0.318	Decreasing returns to scale
HYV in both variety user farmers	0.339	Decreasing returns to scale

Problems Faced by Rice Farmers in the Study Area

The rice farmers face various problems during the farming operations. Some of them are higher input price but lower output price, transportation problems, natural disaster (i.e., drought, stone-rain, flood etc.), lack of the supply of electricity in irrigation seasons, financial constraints, implementation problem of government policy, spread of artificial seeds, unstable price of agriculture product, marketing problem, lack of underground water, and attack of insecticide. Now- a- days credit availability is being a major problem for the rice production in the study area.

Conclusion and Policy Recommendations

The core message of this study is to construct a skeleton of the rice production function in Rajbari district of Bangladesh for which seven explanatory variables and various econometrical tools were used for the model specification which was used in regression analysis. The rice cultivation in the study area is profitable for all type of varieties and the profit of HYV's rice is larger than that of LV.

By the results of this study, some important policies are made for increasing the rice production, which are:

- Many farmers remained untouched in the field of adoption of modern technology. Therefore, to ensure the sustained development of rice production, modern technologies and their facilities should be reached to the hands of the farmers.
- The disguised unemployment exists within the farmers group especially in case of LV user and it was seen from the positive coefficient and insignificant values of labor input, so scopes to migrate labor from agriculture to non-agriculture sector make it more significant.
- Developing newer technologies in order to increase the volume of rice production should be the most important policy because most of the farmers produce rice under the condition of decreasing RTS.
- Providing proper training of the farmers on the method of using fertilizer and insecticides.

- The price support programme for rice should be strictly followed round the year, especially in the harvesting period. If this programme will be ensured, it will give incentive to farmers in increasing the volume of rice production.
- The government should command DAE, BRRI, BARI, NARS institute, private companies and NGOs to develop their own HYV seed and provide them in time to the farmers as seed plays a significant role on production. Moreover, it is necessary to mention that, seed agency will not provide any seed without issuing its accuracy by government agencies.
- Since the whole study area communication facilities are not good, so better road facilities should make.
- Since irrigation is the key variable and plays a significant role for producing rice of all varieties in the Rajbari district. Therefore, electricity facility should make continuous in the time of irrigation over the study area.

REFERENCES

Bangladesh Bureau of Statistics (BBS), 1998. *Statistical Yearbook of Bangladesh* 1998. Dhaka: Statistics Division .Ministry of Planning. Government of the People's Republic of Bangladesh.

Bangladesh Bureau of Statistics (BBS), 2010. *Yearbook of Agricultural Statistics of Bangladesh* 2010. Dhaka: Statistics Division, Ministry of Planning. Government of the Peoples Republic of Bangladesh.

Bangladesh Bureau of Statistics (BBS), 2011. *Yearbook of Agricultural Statistics of Bangladesh* 2011. Dhaka: Statistics Division, Ministry of Planning. Government of the Peoples Republic of Bangladesh.

Bhujel, R.B. and Ghimire, S.P. (2006), **"**Estimation of production function of Hiunde (Boro) Rice", Regional Agriculture research Station, Tarahara, Sunsari, Nepal. *Nepal Agric. Res. J.,* Vol.7.

Biyi, D. (2005),"Government policies and competitiveness of Nigerian Rice Economy", Paper presented at the "workshop on Rice policy and Food security in sub – Saharan Africa" organized by WADA, Cotonon, Republic of Benin.

Chandler, R. F. (1979), *Rice in the Tropics: A Guide to the development of National Programme*, P. 300.

Eleanor, R. F. (1975), Rice Franklin Watts Limited, Ivere Street London, W. I. p. 300. Government of Bangladesh. *Bangladesh Economic Review* 2013, Economic Advisory Wings, Finance Division, Dhaka: Ministry of Finance, Dhaka.

Gujarati, D.N. (2003), *Basic Econometrics,* Fourth edition. New York. McGraw Hill, Inc.

Hussain, M. A. and Saed, A. A. J. (2001),"Econometric estimation of agricultural production function in Jordan: 1981 – 1996", *Journal of economic and administrative sciences*, Vol. 17, pp. 90 – 103.

Koutsoyannis, A. (1979), *Modern Microeconomics*. Macmillan Education Ltd, London and Basinstock.

Majumder, M.K., Mozumdar, L., and Roy, P.C.(2009),"Productivity and Resource Use Efficiency of Boro Rice Production. Department of agricultural economics, Department of Rural Sociology, and Department of agricultural extension education, Bangladesh agricultural university, Mymensingh- 2202, Bangladesh",*J. Bangladesh agril. Univ*.,Vol. 7 No. 2, pp. 247- 252.

Moniruzzaman, M. Shuhel., M.M.H. Feardous, M.A., Hasan, M.R. and Sarkar, M.S.K. (2010), "Comparative Economic Analysis of Borrower and Non-borrower Boro Rice Farmers in Some Selected Sites of Mymensingh District", *Bangladesh Journal of Agricultural Research*, Vol. 35 No. l, pp-65-67.

Olujenyo, F.O.(2008), "The Determinants of agricultural production and profitability in Akoko land, Ondo- State, Nigeria. Adekunle Ajasin University, Akungba Akoko, Ondo State, Nigeria", *Journal of social sciences*,Vol. 4 No. 1, pp. 37-41.

Rushidan, I. (2002),"Determinants of the Use of Modern Inputs and Agricultural Productivity in Bangladesh", *The Bangladesh Institute of Development Studies*, Vol. 47 No. 1, pp. 47-79.

--0--